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leached by surface waters, which take into solution various metals and passing downward meet with and are decomposed by the sulphides of iron present in the unaltered ore, resulting in the redeposition of new sulphides of the metals.

This is followed by a description of the mode of occurrence of secondary sulphide ores of copper, silver, and zinc, as studied by the author and others. The enrichment in many cases proceeds along barren fractures producing bonanzas. In others it forms films, paystreaks, or ore shoots in the body of leaner original ore. In still other cases the alterations are produced by deep-seated uprising waters acting upon the vein. As a consequence of these processes veins do not increase in richness in depths below the zone of enrichment.

J. P. I.

Origin and Classification of Ore Deposits. By CHARLES R. KEYES. Trans. American Inst. Mining Eng., Vol. XXX; 34 pp., 1900.

The various attempts that have been made in the past to formulate a rational and at the same time a useful classification of ore deposits have met with only indifferent success. The fundamental factor in the proposed scheme by Dr. Keyes is geological in nature. It is based upon the principle that local deposition and specific form of the ore body is dependent upon geological structures, and these largely govern also the exploitation of the ores. This is believed to be as nearly as it is possible to approach a purely genetic arrangement. The great geological processes are made the governing principles.

Although the present memoir discusses only the classificatory aspects of the ore deposits, it is an application of the modern principles of petrology, and especially those dealing with the processes involved in general rock metamorphism, and it opens the field for fuller explanations and applications of these principles.

Three propositions are emphasized: First, ore bodies with few exceptions are regarded as essentially surface deposits—that is, they are considered as confined to a very thin zone near the earth's surface, or more precisely in the outer belt of the zone of fracture of the lithosphere; second, most of the worked deposits of the globe are thought to be of very late geological formation, probably few dating back before the Tertiary; third, ore bodies are believed to be concentrated chiefly by circulating waters that have come up from below, down from above, or in from the sides, it being immaterial from which direction.

Of recent years there has been a growing tendency for the large mining companies to pay more attention to the geological features of their properties, and in many cases a regularly trained geologist has been employed. Dr. Keyes emphasizes this fact when he says that "When a specially trained geologist undertakes to make an investigation of a mining property, he first gets his bearings, as it were, with regard to the geological structure of the region and the distribution of the rock formations. At once he eliminates nine tenths of the chances of failure in arriving at the best plan for practical operation. Instead of a great game of chance, the development becomes a strictly business proposition."

After briefly discussing the nature of ore deposits, the general methods of ore formation, and the character of the literature, the criteria for ore classification are formulated. The following table sums up the proposed scheme:

CLASSIFICATION OF ORE DEPOSITS.

Groups.	Categories.	Miners' Forms.
I. Hypotaxic. Mainly surface deposits.	Aqueous transportation.	Placers.
	Residual cumulation.	Pockets (in part).
	Precipitative action.	Bog-bodies, some beds, layers.
II. Eutaxic. Chiefly stratified formations.	Original sedimentation.	Beds, strata, layers.
	Selective dissemination.	Impregnations (in part).
	Emponded amassment.	Masses (in part), some segregations.
	Fold-filling.	Saddle-reefs.
	Crevice accretion.	Gash-veins, stock-works (in part).
	Concretionary accumulation.	Nodules.
	Metamorphic replacement.	Fahlbands (in part), beds.
III. Ataxic. Predominantly unstratified and irregular bodies.	Magmatic secretion.	Masses (in part), some lenses.
	Metamorphic segregation.	Stocks, lenses.
	Fumerole impregnation.	Contact-veins, some impregnations.
	Preferential collection.	Chambers (in part), some pockets, linked-veins.
	Fissure occupation.	Attrition-veins (in part), some linked-veins, true veins.

The principal points which the memoir dwells upon are:

1. The main feature wherein the scheme of classification offered differs from others is in the prominence given to geological occurrence and the direct operation of the geological processes as essential factors in the genesis of ore bodies.

2. The nearest approach to a purely genetic classification of ore deposits is believed to be found in their geological relationships, as determined by the great groups of geological processes, and not in their direct chemical formation or physical shapes.

3. The chemical reactions so widely used as criteria of ore classification are to be regarded as general agencies, and therefore they are not available in the specific determinations of the various classes of ore bodies.

4. In the discovery and exploitation of ores, structure is of first importance, that is, the structure of the inclosing country rocks.

5. The primary groupings of ore bodies appear to be best indicated when based upon their geological occurrence, as governed by the nature of geological processes operating.

6. The secondary groupings appear to be best based upon the general form of the ore bodies as geological formations produced by the grander geological agencies.

7. The ternary groupings are best based upon the specific phases of the geological processes involved in the formation of ores as ore bodies.

8. The source of the ore materials is an unessential factor in their classification, the great practical question being, how are ores best exploited? In this connection it matters little what was the original condition of the ores. Nor have we to do very much with the detailed, complex, and usually fanciful chemical reactions that are supposed to take place before the final stage of the ore, as we find it, is reached.

9. Ore bodies of very similar appearance may be formed by very different methods—a fact which, while apparent in all classifications, does not necessarily vitiate any.

10. Finally, the proposed scheme is merely suggestive. It is the barest outline of what is believed to be capable of much farther expansion and development into a comprehensive, rational, and practical general plan.

C. F. M.